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(54) **End of cut speed control system**

Schnittendegeschwindigkeitsregelsystem

Commande de vitesse de coupe en fin de coupe

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Description

[0001] This invention relates to mowers for golf course fairways and greens, and more specifically to an end-of-cut speed control system.

Fairway mowers and greens mowers are self-propelled riding mowers having multiple cutting units providing a high quality cut, and may be capable of mowing successfully at ground speeds as high as 7 to 10 miles per hour.

[0002] Such a mower is described in US 2009/0235627 A1, in which a pedal position sensor and a hand lever position sensor are provided to input the desired engine and propelling speed to a control circuit. The control circuit receives a signal indicating whether a PTO switch is closed and can, dependent on the position of the lever, operate in a manual mode in which the propelling speed is controlled based upon the lever position and an automatic mode in which the propelling speed depends on the pedal position.

[0003] After each cross cut pass of a fairway or green, the operator may raise the cutting units and turn the mower around 180 degrees before making the next pass. This is referred to as the end-of-cut. When a fairway or greens mower travels at these high speeds at the end-of-cut, there may be a risk of damage to the turf as the wheels and tires of the mower make sharp turns on soft ground. To reduce or prevent turf damage, golf course management may adjust mow speed controls to maximum ground speeds of only 3 to 6 miles per hour. This results in a significant reduction of productivity. There is a need for a fairway or greens mower that can mow at high ground speeds without damaging turf at the end-of-cut. There is a need to increase productivity when mowing golf course fairways or greens.

[0004] An end-of-cut speed control system includes a sensor that detects and provides signals to a vehicle controller indicating if a plurality of cutting units on a fairway or greens mower are in a lowered mow position or a raised cross cut position. The vehicle controller reduces the traction drive speed of the mower if the cutting units are in the raised cross cut position. The amount of traction drive speed reduction may be based on an end-of-cut speed that may be preset on a display module on the mower.

[0005] Fig. 1 is a drawing of a fairway mower having an end-of-cut speed control system according to one embodiment of the invention.

[0006] Fig. 2 is a flow diagram of an end-of-cut speed control system according to one embodiment of the invention.

[0007] In an embodiment shown in Fig. 1, mower 100 includes an end-of-cut speed control system that reduces the mower's ground speed at the end-of-cut across a fairway or green. The end-of-cut speed control system is shown on a self-propelled fairway mower, and also may be used on self-propelled riding greens mowers or other self-propelled riding mowers that have multiple cutting units providing a high quality cut. The cutting units

preferably include a first or front row of cutting units 102 connected to lift arms 104, and a second or rear row of cutting units 103 also connected to lift arms. The cutting units are preferably cutting reels, but also may be rotary cutting units.

[0008] Now referring to Fig. 2, end of cut speed control system 106 may include vehicle controller 108 that controls the ground speed of a fairway or greens mower based on input signals from one or more forward pedal sensors 110, one or more reverse pedal sensors 112, and swash plate sensor 114 of electronically controlled hydrostatic or eHydro pump 116. The input signals from the forward and reverse pedal sensors may include PWM voltages indicating desired ground speed based on pedal position at a known and/or fixed engine speed. The input signal from the swash plate sensor may be a DC voltage indicating swash plate angle or position for a ground speed at the same known and/or fixed engine speed. Based on these inputs, the vehicle controller may determine the amount of DC current to forward and reverse pump valves 118, 120 to make any change to swash plate position. The DC current output may be based on the amount of error between ground speed demanded by the pedals and the swash plate position.

[0009] In one embodiment, a fairway or greens mower with the end of cut speed control system may have several modes of operation based on the position of PTO switch 122 that turns on hydraulic or electric cutting unit motors 124, and one or more proximity switches 126 that sense if the cutting units are on the ground or raised to a cross cut position. These switches may provide DC voltage inputs to vehicle controller 108. Although proximity switches are preferred, other types of sensors may be used to detect if the cutting units are on the ground or raised to a cross cut position. The operating modes may include a transport mode if the PTO switch is off, a mow mode if the PTO switch is on and the proximity switches detect the cutting units are on the ground in the mow position, and an end of cut mode if the PTO switch is on and the proximity switches detect the cutting units are partially raised off the ground at the cross cut position. In the transport position, the cutting units may be raised completely, including raising the wing cutting units to hang vertically so the mower may have a narrower transport width.

[0010] In one embodiment, the end of cut speed control system may include display module 128 connected by a CAN bus to the vehicle controller. The display module may have several controls that an operator may use to set a maximum transport mode ground speed, a maximum mow mode ground speed, and an end of cut mode ground speed that may be a percentage of the mow mode ground speed. The display module and/or vehicle controller preferably may limit access to the controls and/or block or restrict adjustment of the settings while the mower is moving.

[0011] In one embodiment, the end of cut speed control system may include lower switch 130 that provides DC

voltage input to the vehicle controller, causing the cutting units to be lowered to the ground. The mower may cut grass in the mow mode only if lower switch 130 is actuated, PTO switch 122 is on, and proximity switches 126 sense the cutting units are below a predetermined height (essentially on the ground in a mow position).

[0012] In one embodiment, the end of cut speed control system may include raise switch 132 that provides DC voltage input to the vehicle controller. The mower may change from the mow mode to the end of cut mode when the operator actuates the raise switch. The raise switch causes the cutting units to raise to a predetermined height above the ground, and preferably less than about 10 inches off the ground, to a cross cut position. The raise switch may raise the cutting units using hydraulic lift valves or electric actuators, which may be electronically timed to raise the front cutting units before the rear cutting units. Additionally, actuating the raise switch may cause the ground speed of the mower to be reduced. The vehicle controller may provide current to the pump valves based on the equation: reduced speed = (current ground speed based on pedal position) x (end of cut speed percentage selected on display module). In the end of cut mode, the operator may continue to hold his foot down on the forward pedal, even when turning the mower around at the end of cut across a fairway or green.

[0013] In one embodiment, the end of cut speed control system may change from the end of cut mode to the mow mode when the operator actuates lower switch 130, causing the hydraulic lift valves or electric actuators to lower the cutting units back to the ground in the mow position. If PTO switch 122 remains on, and proximity switches 126 sense the cutting units are below a predetermined height, the vehicle control unit may command the pump valves to operate at a ground speed based on pedal position without any reduction by the end of cut speed percentage.

[0014] In an alternative embodiment, the end of cut speed control system may include an electric traction drive system having electric wheel motors instead of a hydrostatic drive system. For example, the vehicle control unit may provide commands to electric wheel motors to a reduced ground speed in the end of cut mode, as a percentage of the current ground speed. In another alternative, the vehicle control unit may reduce the maximum ground speed of the traction drive system in the end of cut mode.

[0015] In one embodiment, the end of cut speed control system may include proximity switches that detect flags 134 on each lift arm of a front cutting unit, or another characteristic or feature of a lift arm or cutting unit, to determine if the cutting units are on the ground or not.

[0016] In one embodiment, the vehicle control unit may ramp up or down the ground speed between the mow mode and the end of cut mode. The rate of change may use an algorithm designed to ramp to the reduced ground speed, or back up to the unreduced speed, within less than about 1 second.

[0017] In one embodiment, the vehicle controller may be connected to the sensors and switches by a system bus or CAN bus.

[0018] In one embodiment, a fairway or greens mower with the end of cut speed control system may operate in the mow mode at ground speeds as high as 7 to 10 miles per hour, with reduced or minimal turf damage when reaching the end of cut and turning. The clip frequency of the reel cutting units may be set for the higher ground speed.

Claims

1. A mower (100) having an end-of-cut speed control system (106), comprising:

a forward foot pedal sensor (110) providing signals to a vehicle controller (108) that commands a traction drive system of the mower (100);
 a PTO switch (122) providing signals to the vehicle controller (108) and turning on cutting motors (124) on a plurality of cutting units (102);
characterized in that a proximity switch (126) is provided, operable to provide signals to the vehicle controller (108) indicating if the plurality of cutting units (102) are on the ground in a mow position or are raised to a cross cut position;
in that a display module (128) is operable to provide signals to the vehicle controller (108) based on a setting of a control to a maximum mow mode ground speed and a setting of a control to an end-of-cut mode ground speed as a percentage of the mow mode ground speed;
 and **in that** the vehicle controller (108) is operable to command the traction drive system to a reduced ground speed determined as the product of a current ground speed based on the signals from the forward foot pedal sensor (110) and the end-of-cut speed percentage, if the PTO switch (122) is on and the proximity switch (126) indicates the cutting units (102) are raised to the cross cut position.

2. The mower (100) according to claim 1, wherein the cutting units (102) include a first row of cutting units (102) and a second row of cutting units (102), and further comprising a raise switch (132) and a lower switch (130) providing signals to the vehicle controller (108) and raising or lowering the first row of cutting units (102) before the second row of cutting units (102).
3. The mower (100) according to claim 1 or 2, wherein the vehicle controller (108) commands the traction drive system to the mow mode ground speed based on pedal sensor position if the PTO switch (122) is on and the proximity switch (126) indicates the cut-

ting units (102) are on the ground in the mow position.

4. The mower (100) according to one of the claims 1 to 3, wherein the cutting motors (124) are electric motors (124) on cutting reels. 5
5. The mower (100) according to one of the claims 1 to 4, wherein the vehicle controller (108) determines the amount of the ground speed reduction by applying the preset end-of-cut speed to an actual ground speed of the mower (100). 10
6. The mower (100) according to one of the claims 1 to 5, wherein a maximum ground speed may be preset on the display module (128) on the mower (100). 15
7. The mower (100) according to one of the claims 1 to 6, wherein the proximity switch (126) detects the position of one of a plurality of lift arms for the cutting units (102). 20

Patentansprüche

1. Rasenmäher (100) mit einem Schnittendegeschwindigkeit-Steuersystem (106), das Folgendes umfasst:

einen Vorwärts-Fußhebelsensor (110) zum Bereitstellen von Signalen an eine Fahrzeugsteuerung (108), die ein Traktionsfahrssystem des Rasenmähers (100) befiehlt;

einen Nebenabtriebschalter bzw. PTO-Schalter (122) zum Bereitstellen von Signalen an die Fahrzeugsteuerung (108) und zum Einschalten der Schnittmotoren (124) in einer Vielzahl von Schnitteinheiten (102);

dadurch gekennzeichnet, dass ein Näherungsschalter (126) vorgesehen ist, der betreibbar ist zum Bereitstellen von Signalen an die Fahrzeugsteuerung (108), die anzeigen, ob sich die Vielzahl von Schnitteinheiten (102) in einer Mähstellung am Boden befindet oder auf eine Kreuzschnittstellung erhöht ist;

dass ein Anzeigemodul (128) betreibbar ist zum Bereitstellen von Signalen an die Fahrzeugsteuerung (108), basierend auf einer Einstellung einer Steuerung auf eine maximale Mähmodus-Bodengeschwindigkeit und einer Einstellung einer Steuerung auf eine Schnittemodus-Bodengeschwindigkeit als ein prozentualer Anteil der Mähmodus-Bodengeschwindigkeit;

und dass die Fahrzeugsteuerung (108) betreibbar ist zum Befehlen des Traktionsfahrsystems zu einer verringerten Bodengeschwindigkeit, die als das Produkt einer aktuellen Bodengeschwindigkeit, die auf den Signalen von dem Vorwärts-Fußhebelsensor (110) basiert, und

dem prozentualen Anteil der Schnittendegeschwindigkeit bestimmt wird, falls der PTO-Schalter (122) an ist und der Näherungsschalter (126) anzeigt, dass die Schnitteinheiten (102) in die Kreuzschnittstellung angehoben sind.

2. Rasenmäher (100) nach Anspruch 1, wobei die Schnitteinheiten (102) eine erste Reihe von Schnitteinheiten (102) und eine zweite Reihe von Schnitteinheiten (102) beinhalten, und der ferner einen Anhebeschalter (132) und einen Absenkschalter (130) umfasst, die Signale an die Fahrzeugsteuerung (108) liefern und die erste Reihe von Schnitteinheiten (102) vor der zweiten Reihe von Schnitteinheiten (102) anhebt oder absenkt.
3. Rasenmäher (100) nach Anspruch 1 oder 2, wobei die Fahrzeugsteuerung (108) das Traktionsfahrssystem in die Mähmodus-Bodengeschwindigkeit befiehlt, basierend auf der Pedalsensorstellung, falls der PTO-Schalter (122) an ist und der Näherungsschalter (126) anzeigt, dass die Schnitteinheiten (102) in der Mähstellung am Boden sind.

4. Rasenmäher (100) nach einem der Ansprüche 1 bis 3, wobei die Schnittmotoren (124) Elektromotoren (124) auf Schneidespindeln sind.

5. Rasenmäher (100) nach einem der Ansprüche 1 bis 4, wobei die Fahrzeugsteuerung (108) die Höhe der Bodengeschwindigkeitsverringern durch Anwenden der voreingestellten Schnittendegeschwindigkeit auf eine tatsächliche Bodengeschwindigkeit des Rasenmähers (100) bestimmt.

6. Rasenmäher (100) nach einem der Ansprüche 1 bis 5, wobei eine maximale Bodengeschwindigkeit auf dem Anzeigemodul (128) auf dem Rasenmäher (100) eingestellt werden kann.

7. Rasenmäher (100) nach einem der Ansprüche 1 bis 6, wobei der Näherungsschalter (126) die Stellung von einem aus einer Vielzahl von Hubarmen für die Schnitteinheiten (102) detektiert.

Revendications

1. Tondeuse (100) comportant un système de commande de vitesse de fin de coupe (106), comprenant :

un capteur de pédale de marche avant (110) fournissant des signaux à un dispositif de commande de véhicule (108) qui commande un système d'entraînement de traction de la tondeuse (100) ;

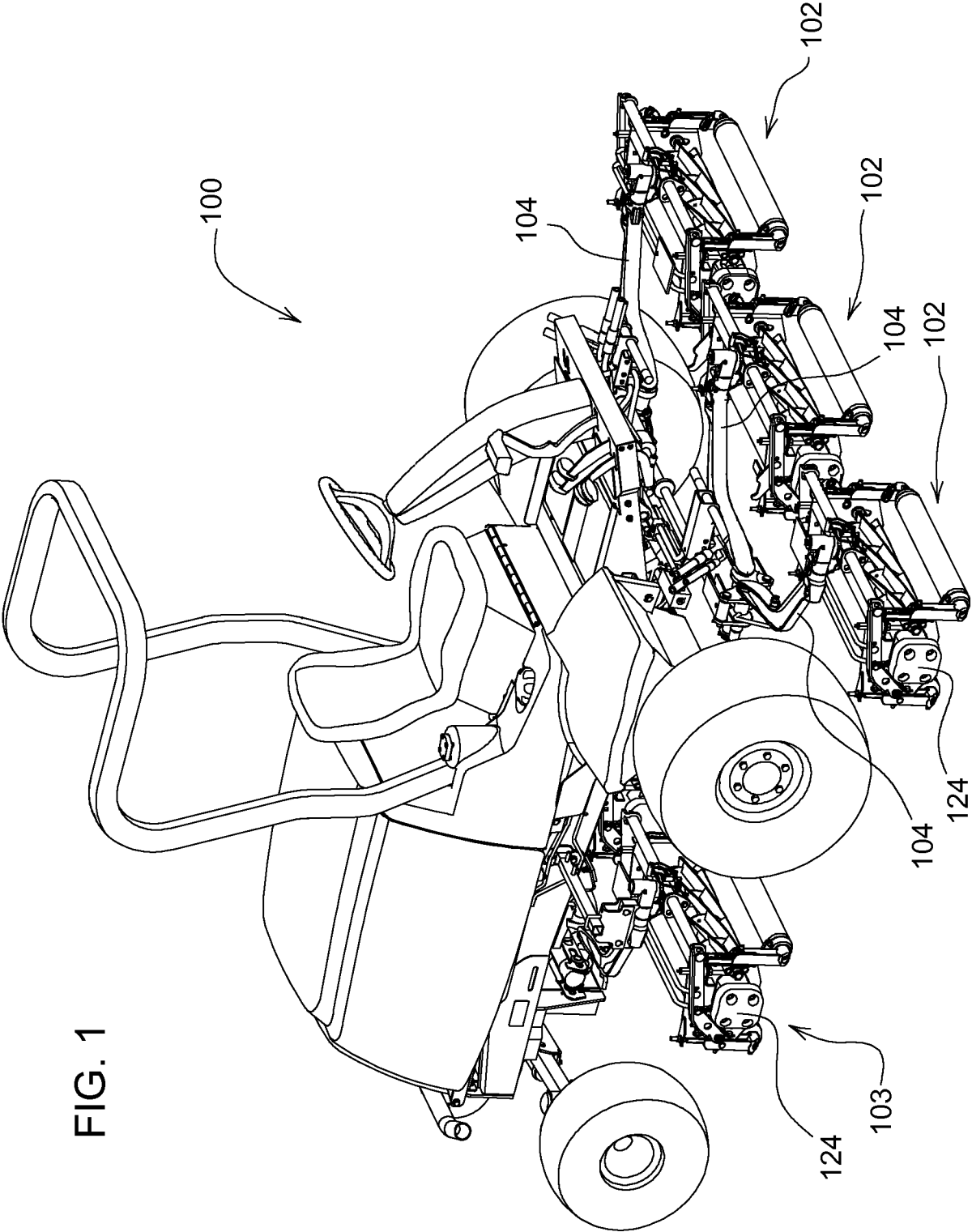
un interrupteur de prise de force (122) fournis-

sant des signaux au dispositif de commande de véhicule (108) et allumant des moteurs de coupe (124) sur une pluralité d'unités de coupe (102) ; **caractérisée en ce qu'un** interrupteur de proximité (126) est prévu, celui-ci pouvant être mis en oeuvre pour fournir des signaux au dispositif de commande de véhicule (108) indiquant si la pluralité d'unités de coupe (102) se trouvent sur le sol dans une position de tonte ou sont relevées jusqu'à une position de coupe transversale ;

en ce qu'un module d'affichage (128) peut être mis en oeuvre pour fournir des signaux au dispositif de commande de véhicule (108) sur la base d'un réglage d'une commande jusqu'à une vitesse au sol maximale en mode de tonte et d'un réglage d'une commande jusqu'à une vitesse au sol en mode de fin de coupe sous forme de pourcentage de la vitesse au sol en mode de tonte ;

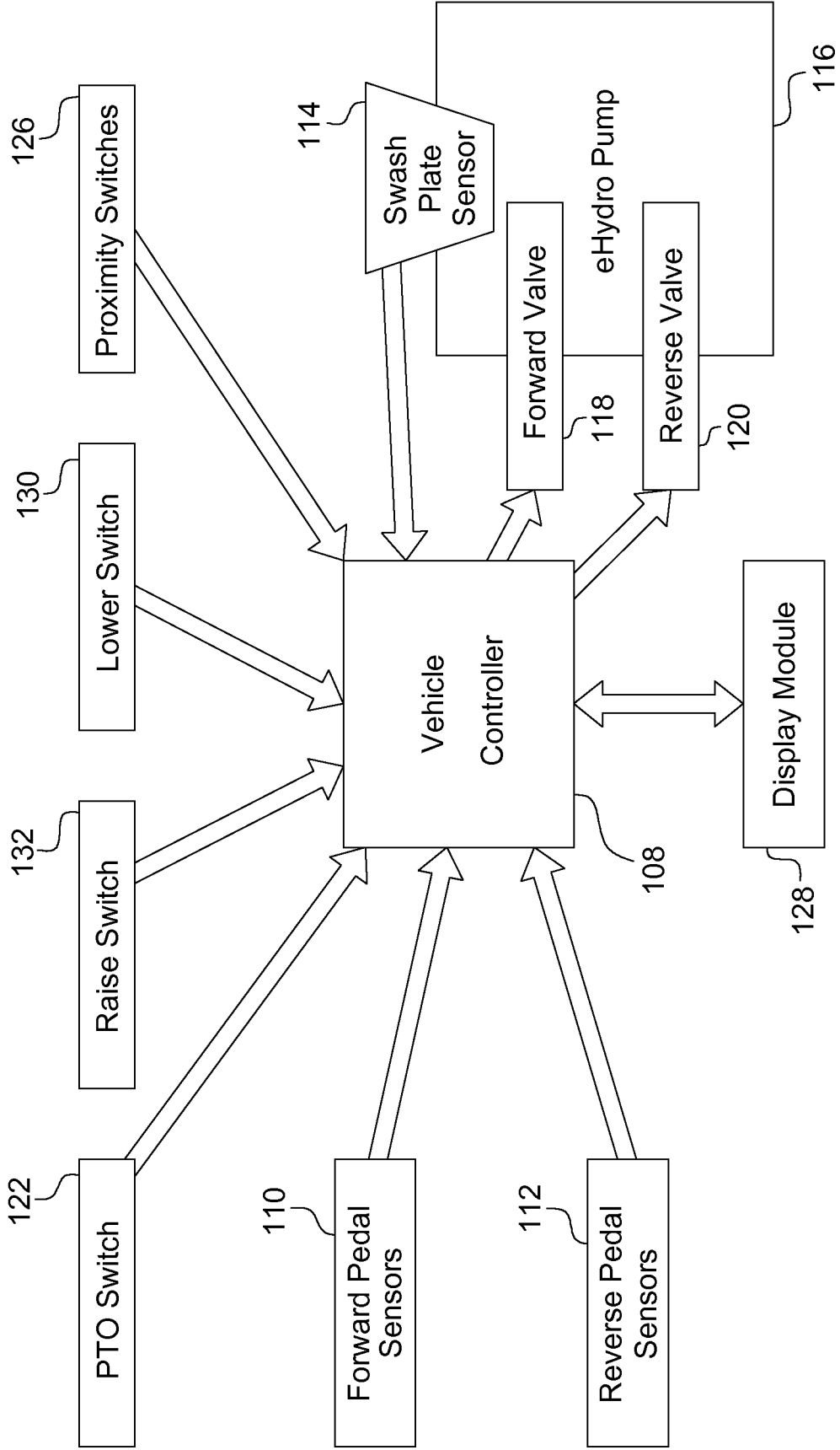
et **en ce que** le dispositif de commande de véhicule (108) peut être mis en oeuvre pour donner l'instruction au système d'entraînement de traction d'adopter une vitesse au sol réduite déterminée comme le produit d'une vitesse au sol actuelle sur la base des signaux provenant du capteur de pédale de marche avant (110) et du pourcentage de vitesse de fin de coupe, si l'interrupteur de prise de force (122) est allumé et l'interrupteur de proximité (126) indique que les unités de coupe (102) sont relevées jusqu'à la position de coupe transversale.

2. Tondeuse (100) selon la revendication 1, dans laquelle les unités de coupe (102) comprennent une première rangée d'unités de coupe (102) et une seconde rangée d'unités de coupe (102), et comprenant en outre un interrupteur de levage (132) et un interrupteur d'abaissement (130) fournissant des signaux au dispositif de commande de véhicule (108) et relevant ou abaissant la première rangée d'unités de coupe (102) avant la seconde rangée d'unités de coupe (102).
3. Tondeuse (100) selon la revendication 1 ou 2, dans laquelle le dispositif de commande de véhicule (108) donne l'instruction au système d'entraînement de traction d'adopter la vitesse au sol de mode de tonte sur la base de la position du capteur de pédale si l'interrupteur de prise de force (122) est allumé et l'interrupteur de proximité (126) indique que les unités de coupe (102) se trouvent sur le sol dans la position de tonte.
4. Tondeuse (100) selon l'une des revendications 1 à 3, dans laquelle les moteurs de coupe (124) sont des moteurs électriques (124) sur des cylindres de coupe.
5. Tondeuse (100) selon l'une des revendications 1 à 4, dans laquelle le dispositif de commande de véhicule (108) détermine la quantité de réduction de la vitesse au sol en appliquant la vitesse de fin de coupe préétablie à une vitesse au sol réelle de la tondeuse (100).
6. Tondeuse (100) selon l'une des revendications 1 à 5, dans laquelle une vitesse au sol maximale peut être préétablie sur le module d'affichage (128) sur la tondeuse (100).
7. Tondeuse (100) selon l'une des revendications 1 à 6, dans laquelle l'interrupteur de proximité (126) détecte la position d'un bras parmi une pluralité de bras de levage pour les unités de coupe (102).



106 ↗

FIG. 2



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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